

# Yellow-Cheeked Voles and Fire along the Upper Kobuk River Valley, Alaska

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Since 1991 the National Park Service (NPS) has been collecting natural resource information from the Kobuk Preserve Unit of Gates of the Arctic National Park and Preserve. This information will enable NPS staff to make knowledgeable decisions regarding potential road development across the Kobuk Preserve Unit to the Ambler Mining District (as authorized under the park's establishing legislation).

Voles, shrews and lemmings are small but integral components of the taiga ecosystem in the upper Kobuk River Valley. Wildfire is another integral component of this ecosystem, and the abundance and distribution of several small mammal species appears to be affected by it. In 1992, NPS initiated a three-year study to look at the relationship between small mammal abundance and distribution in different-aged, post-fire black spruce stands (S. Swanson 1996). Species captured during the study included red-backed voles, yellow-cheeked voles, masked shrews, dusky shrews, pygmy shrews, northern bog lemmings and brown lemmings. Findings from this study pertaining to yellow-cheeked voles, their habitat and wildfire are presented in this article.

*Location of the Kobuk Preserve Unit within Gates of the Arctic National Park and Preserve, Brooks Range, Alaska.*

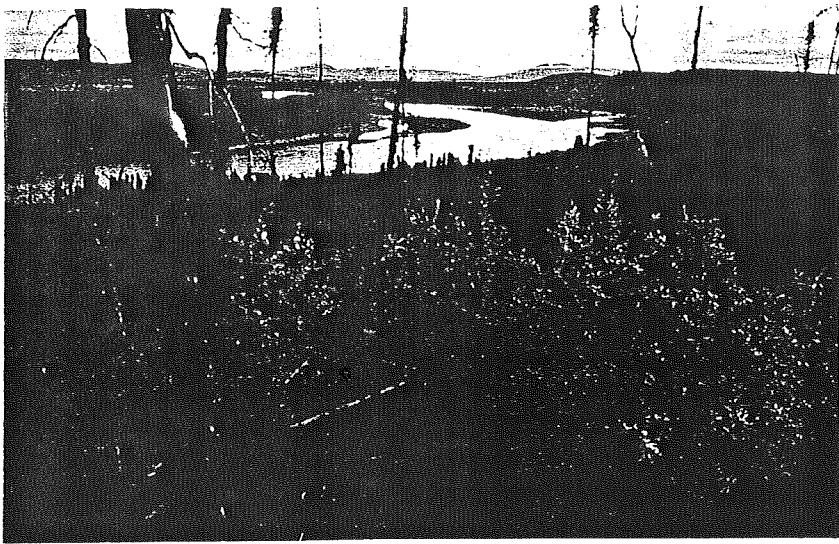


## Kobuk Country

The study was conducted in the Kobuk Preserve Unit of Gates of the Arctic National Park and Preserve, Alaska. The Kobuk River, a designated Wild and Scenic River, is located in Pleistocene glacial deposits along the southern foothills of the Brooks Range. The topography ranges from undulating plain in the valley bottom to high hills and low mountains forming the valley sides. The Kobuk Valley area has a subarctic continental climate: summers are short and warm with frequent light rain, and winters are long and cold. Rain appears to be a constant companion in the Kobuk River Valley, particularly in August. In August 1994 (the third year of the study), extensive rain precipitated a 100-year flood in the Kobuk and Koyukuk River drainages; the entire area was declared a Federal disaster area.

Black spruce forest communities dominate the valley floor; black and white spruce is interspersed with occasional birch and aspen trees on the dry hilltops. Balsam poplar stands occur in the floodplain and along drainage areas. Study sites selected for this project were situated in mesic black spruce vegetation in two areas along the Kobuk River. One grid pair was placed in lichen woodland habitat, with one grid in a one-year-old burned area and the other in nearby unburned mature vegetation; these grids were established in 1992. The lichen woodland grids were located on old stream terraces of alluvium. The ground cover on the burned lichen woodland grid was composed of burned reindeer lichen, downed wood and bare soil interspersed with unburned sphagnum moss hummocks. Black spruce trees on the mature lichen woodland grid were 6–8 m tall, with smaller seedlings growing underneath. The ground cover on this grid was composed of dense lichen mat.

The second grid pair (studied in 1993 and 1994) was set up in moss/shrub forest habitat, with one grid in a 16-year-old burn and its complement in nearby mature forest. The shrub layer was the most highly developed vegetation component on the burned moss/shrub forest site and consisted of blueberry, lingonberry, Labrador tea and dwarf birch. Standing dead trees, 3–4 m in height, were interspersed throughout the area. The vegetation on the mature moss/shrub forest was classified as open black spruce forest, a common climax vegetation



*View of the Kobuk Valley from the burned moss/shrub forest grid, Gates of the Arctic National Park and Preserve.*

stage on cold, poorly drained sites (Viereck et al. 1992). The ground cover was predominantly moss/lichen mat with a shrub layer of blueberry, dwarf birch and Labrador tea. Multi-strata black spruce made up the remainder of the overstory.

### *How to Build a Better Mouse Trapping Grid*

Field work was conducted in August each year to sample peak annual small-mammal populations. Trap stations, consisting of two museum special snap traps (baited with peanut butter and oats) and a pitfall trap, were placed 10 m apart on 100- × 100-m trapping grids. The four grids were operated for 900 trap-nights per grid per year during the study; trap-nights were defined as one trap set for a 24-hour period. Grids were accessed by river travel, helicopter and foot; several trap lines on the hike-in grids were unexpectedly accessible by boat during the 1994 flood.

Captured animals were identified to species, weighed and aged as juvenile, subadult or adult based on molt patterns and weight. Study skins and skeletons were prepared in the field and are now housed at the University of Alaska Fairbanks (UAF) Museum. Small-mammal kidney, heart and liver tissues were collected for the UAF Museum's frozen tissue collection for future research on genetics and environmental pollutants; tissues were quick-frozen and transported in nitrogen tanks. Percent cover was estimated for all plants in a randomly selected 10- × 10-m plot within each trapping grid. Soil classification and stratigraphic information was collected from two soil pits at each grid site. Weather data were evaluated hourly by cold, wet trapping crews, particularly during the 1994 flood, when field camps had to be moved to higher ground on several occasions.

### *Where the Voles Roam*

#### *Life is Good in the Burned Moss/Shrub Forest*

Of the four habitat types studied, small-mammal abundance was highest on the burned moss/shrub forest. Yellow-cheeked voles accounted for 30–31% of the small mammals captured, and more yellow-cheeked voles were captured from this area than from the other areas studied. This relatively high density of yellow-cheeked voles appears to be related to the burrowing conditions and food availability in this habitat type.

Yellow-cheeked vole populations are associated with good burrowing conditions and recently burned sites (West 1979, Wolff and Lidicker 1980). The 1978 fire appears to have changed soil conditions in the area of the burned moss/shrub forest grid, resulting in conditions apparently well suited to yellow-cheeked voles. Following a wildfire the charred, dark soil surface (which has lost its overstory vegetation and insulating mosses) is subject to greater soil heat absorption, and soil temperatures become warmer (Viereck and Schandelmeier 1980). These higher soil temperatures facilitate deeper seasonal thaw levels, and soils become drier in some cases (D. Swanson 1996). This process of soil warming probably occurred on the burned moss/shrub forest grid, since permafrost was not encountered within 1.25 m of the mineral soil. In contrast, permafrost was encountered on the mature moss/shrub forest grid at 55 cm in one soil pit and 100 cm in the other. Also, soils on the burned moss/shrub forest grid did not show evidence of reduction (indicating wet soils) until 30 cm in depth in one soil core and 60 cm in the other, but soils on the mature moss/shrub forest were saturated with water below 12 cm.

The warmer and drier soils in the burned moss/shrub forest grid (and on burned sites in general) may serve as optimal substrates for runway and colony construction and therefore support a relatively high population of burrowing small mammals (when sufficient food is available). Rhodes and Richmond (1985) found that burrowing medium was a critical component of pine vole habitat, and the voles preferred loam/peat moss burrowing substrate where tunnel integrity, reduced resistance to burrowing, and soil moisture factors were highest. The abundance of moss and the moderately deep organic layer on the burned moss/shrub forest grid probably had similar burrowing and digging properties as the loam/peat moss substrate. Organic mat depth also correlates to small-mammal density (Morris 1979, D. Swanson 1996), and the organic layer on this grid was 9 cm, second only to the mature moss/shrub forest grid (20 cm).

Plant composition was probably an important

factor in establishing and maintaining yellow-cheeked vole populations on the burned moss/shrub forest. Plant productivity on recently burned black spruce sites is high in response to high nutrient availability; common post-fire plant species such as fireweed, bluejoint and horsetail particularly benefit from this high nutrient availability (Viereck and Schandelmeier 1980, Viereck 1983). These post-fire plant species are primary food sources for yellow-cheeked voles and are likely critical for colonization of recent burns by this species. Summer foods for yellow-cheeked voles consist of horsetail, graminoids, dicots (forbs) and berries (West 1979, Wolff and Lidicker 1980), plants that were common on the burned moss/shrub forest grid. More graminoids and forbs were found on the burned shrub/moss forest than on the other vegetation types studied, enabling it to support a high yellow-cheeked vole population.

Fireweed and horsetail rhizomes (thickened roots) are critical components of winter food caches for yellow-cheeked voles (Wolff and Lidicker 1980). Since horsetail, bluejoint and fireweed spread into post-fire areas primarily via rhizomes growing in mineral soil (Viereck and Schandelmeier 1980), burn sites should support a plentiful supply of rhizomes for winter food caches (unless fire intensity is high and rhizomes are destroyed). Fireweed and horsetail were relatively abundant in the burned moss/shrub forest grid, and horsetail is a common and relatively abundant forb on most burns less than 50 years old (except on dry sites) in the Kobuk Preserve Unit (D. Swanson 1996).

Post-burn sites retain a well-developed herbaceous layer until the canopy closes late in the tall shrub/sapling stage (sometime within 50 years post-fire) (Foote 1983). Since trees in the burned moss/shrub forest site (16 years post-fire) were still seedling/small shrub height and the canopy was not yet closed, the herbaceous layer was still well developed during the study and capable of sustaining a high population of yellow-cheeked voles.

#### *Life is Hit or Miss in the Mature Moss/Shrub Forest*

Habitat conditions on the mature moss/shrub forest site were apparently marginal for yellow-cheeked voles. Yellow-cheeked voles accounted for only 12% of the animals captured on this site in 1993 and were not captured at all in 1994. Yellow-cheeked voles are found in burn sites (West 1979, Wolff and Lidicker 1980, Johnson and Paragi 1992) and along taiga waterways and lakes where flood and ice disturbance maintains a dense growth of graminoids and light-seeded, quickly developing plants (West 1979). These small areas of consistent habitat may be easily overpopulated, causing excess animals to disperse in search of other suitable disturbed sites. West (1979) speculated that a few voles might be sustained where toppled trees allowed light to reach the forest floor and enhance herbaceous growth. The northeast corner of the mature moss/shrub forest grid, where canopy cover was less than 10% (in contrast to 25–50% closure elsewhere on the grid) and sedge was abundant, may have served as a small pocket of suitable yel-

**Habitat characteristics and corresponding yellow-cheeked vole numbers for four different-aged, post-fire black spruce stands in Gates of the Arctic National Park and Preserve, Alaska, 1992–1994. Soils were characterized at two soil pits on each grid, and measurements reflect the depths at which each feature was first encountered.**

<i>Habitat characteristics</i>	<i>Burned moss/shrub forest</i>	<i>Mature moss/shrub forest</i>	<i>Burned lichen woodland</i>	<i>Mature lichen woodland</i>
Depth of organic layer (cm)	9	20	7	4–5
Depth to reduced and/or saturated soils (cm)	reduced: 30 and 60 saturated: >125	reduced: 12 and 45 saturated: 12 and >125*	reduced: 0 and 6 saturated: 72 and 75	reduced: 65 and 70 saturated: >125
Depth to permafrost (cm)	>125 *	55 and 100	>125 * cryoturbation: 6–20	88 and 122
Tree canopy closure (%)	1	45	10	35
Density of rhizome-producing plants (%)	25	10	5	3
Mean number of yellow-cheeked voles captured	23	6	5	0

\*Soil pits were 125 cm deep; >125 cm indicates that the feature was not encountered in the soil pit.

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This project is part of a cooperative effort by the Koyukuk/Nowina National Wildlife Refuge, the Kanuti National Wildlife Refuge, and the Gates of the Arctic National Park and Preserve to study small mammals in post-fire seral stages.

low-cheeked vole habitat; all yellow-cheeked voles captured on the grid were from this corner. Burrowing conditions were good in the 20-cm organic layer, but soils were wet or frozen below this layer. Graminoid and forb abundances may have been insufficient to sustain a larger yellow-cheeked vole population.

#### *Life is Lonely in Burned Lichen Woodland*

Of the small mammals captured on the grid, yellow-cheeked voles comprised 21% in 1992 and 56% in 1993; however, they were the only small-mammal species captured on the grid in 1994, when small-mammal populations were low on all the grids. All yellow-cheeked voles captured on the burned lichen woodland grid came from a colony situated in the southeast corner. Whether the colony existed prior to the 1991 fire is unknown, but the tremendous increase in excavations in and around the colony between the first and second years of the study indicated that it was expanding. The yellow-cheeked vole colony was situated on an unburned sphagnum moss area; the 1991 fire left burned lichens and bare mineral soil over much of the area, but unburned sphagnum moss hummocks and willow swales were interspersed throughout the burn. Digging conditions in the moss at the colony site appeared to be adequate, and downed trees and sphagnum moss hummocks provided sufficient escape cover.

The yellow-cheeked vole forb/rhizome diet may enable them to establish year-round residency in burned areas before other small-mammal species. Forb and graminoid availability was low during the first year of the study but increased slightly during the second and third years. Rhizomes and early successional forbs and grasses are often available for yellow-cheeked voles well before berry-producing plants are available for other small mammals (such as the red-backed vole); this may enable yellow-cheeked voles to overwinter on a recent burn when other species would have to move to more productive areas with greater berry availability in early to mid-winter.

Food sharing and communal nesting by yellow-cheeked voles in winter may also speed residency establishment on burns. Food caches established during the summer provide 90% of winter foods, which means less time and energy would be spent in foraging activity (Wolff and Lidicker 1980). Communal nesting would also decrease the amount of energy expended per individual to maintain body temperatures. A communal nesting and food sharing system may have enabled yellow-cheeked voles to persist on the burned lichen woodland grid in 1994 when other small-mammal species on the grid either died off or dispersed from the site.

#### *Life Can Be Grim in Mature Lichen Woodland*

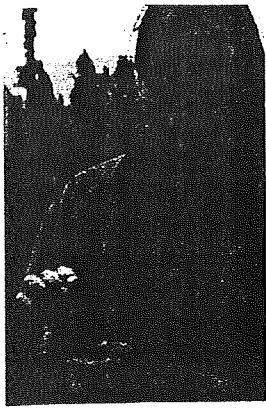
The mature lichen woodland grid had the lowest abundance of small mammals and the lowest species diversity of all four black spruce types examined. Lack of escape cover, food and good digging conditions on the mature lichen woodland grid apparently precluded habitation by yellow-cheeked voles. Yellow-cheeked voles have been positively correlated with areas of greater micro-relief where herbaceous escape cover was abundant; herbaceous escape cover was particularly important in forests with moss- or lichen-dominated understory (such as that on the mature lichen woodland site) (Douglass 1977). Very little vertical herbaceous escape cover was available on this grid, and food sources associated with yellow-cheeked voles on the other grids in the study were either absent or present only in small quantities. Fireweed seldom persists into the mature black spruce stage, and horsetail cover is generally low on mature black spruce forest on permafrost (Foote 1983, D. Swanson 1996). Sedges can be relatively abundant in mature black spruce forest on permafrost (D. Swanson 1996), but they were sparse on this site.

Burrowing conditions for yellow-cheeked voles on this grid were marginal at best. The organic layer was the thinnest of the four grids studied, and moss only accounted for 1–5% of the ground cover. In addition, the soils were cold and wet in this habitat type. Permafrost was encountered at 88 and 122 cm below the organic layer in the two soil pits, and pitfall traps were often partially filled with water.

## *Conclusions*

The impacts of fire on small mammal populations, particularly the long-term effects, are hard to predict. In the short term, wildfire behavior and intensity can determine the soil conditions, the vegetation and consequently the habitat conditions in boreal vegetation communities. Wildfire appears to be an important factor for maintaining populations of yellow-cheeked voles by creating new habitat with good burrowing/digging conditions and abundant food supplies. Wildfire can indirectly alter the typically cold, moderately wet soils present in black spruce communities, making them warmer and drier within a few years post-fire. Yellow-cheeked voles, which create underground colonies and runway systems, seem to find these soil conditions highly compatible with their lifestyle.

Fire also promotes the growth and availability of plant species serving as the voles' main food supplies. Common post-fire plant species such as horsetail, fireweed, sedges and grasses are the pri-



The author with a 120-g yellow-cheeked vole, Gates of the Arctic National Park and Preserve.

mary food sources for yellow-cheeked voles; these plants often survive fires since they are rooted in mineral soil or have light seeds that are easily transported to the newly exposed soil. In addition to consuming the green vegetation from these plants in the summer, the rhizomes they produce are cached by yellow-cheeked voles for winter consumption. As the overstory canopy closes and vegetation composition changes over time, burned areas will likely become less habitable for yellow-cheeked voles. Perhaps they will then be sniffing the winds for the smell of smoke and the new habitat it may promise.

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